Armed Forces College of Medicine

AFCM

Neuroscience module

Clinical Integrated Cases
Session 1

Basic Principles for Clinical Reasoning

1- **Critical thinking**

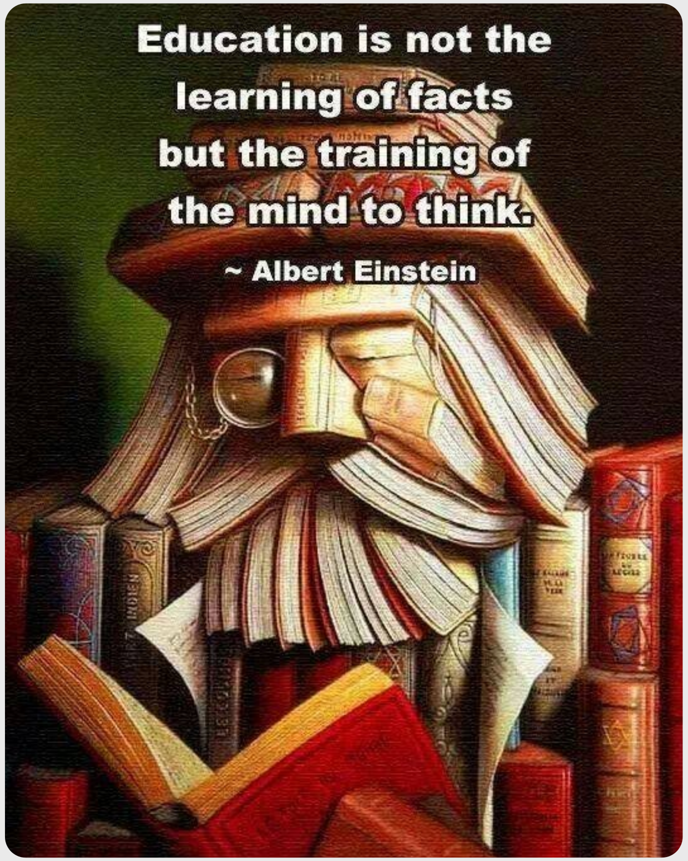
2- **Introduction to common forms of disease**

3- **Problem solving:**

Apply basic knowledge in a realistic clinical scenario.

4- **Interpersonal skills (share and apply your knowledge)**

communication…patient safety



Education is not the learning of facts but the training of the mind to think.

~ Albert Einstein

Case: Terrorist attack

Case coordinator

Prof. Drs. Manal Hassan, Lamiaa Foad, Mona Mokhtar, Mohammed Edrees

Sharing departments

- **Neurology department**
- **Physiology department**
- **Anatomy department**
- **Histology department**

- **Pharmacology department**

Terrorist attack

During a routine mission, colonel Mohammad was driving the Jeep with his friend Samy sitting in the right seat; a Terrorist suicide truck driver came in the way and exploded. Mohammad turned the car steeply. However, he couldn’t control the steering wheel and his car turned upside down and stopped by the edge of the road. Both Friends were ejected from the car.

When the rescuers arrived, they were divided into two groups; each concerned with one of the officers.

Terrorist attack

Samy was screaming from **agonizing neck pain** and was **unable to move his right upper and lower limbs**.

Mohammed was **in pain** and anxious because **he couldn’t move both upper and lower limb.**

Terrorist attack

e rescuers examined the Vital signs

Samy:
BP: 75/50 mmHg,
Pulse: 60/ min.
Respiratory rate:18/min. with normal breathi

https://www.youtube.com/watch?v=fY7SAR5RXbY

Mohammed:
BP: 60/40mmHg,
Pulse: 55/ min
Respiratory rate: 17/min. with normal breathing pattern

When they reached the hospital, they started **pain killers**, **Intravenous fluids**, and **corticosteroids**.

1- What is the first step that should be done by the rescuers?

- ABC
- Ensure safe transportation.
- Good fixation for cervical spines with collar.

How to transfer the patients?

https://youtu.be/-_OkMf_umyE

Samy had **agonizing neck pain** and **unable to move his right upper and lower limbs**.

What are the probable causes?

fragment inserted in his neck, whip lash injury, broken vertebrae

Samy:

BP: 75/50 mmHg,

Pulse: 60/ min.

Respiratory rate:18/min. with normal breathing pattern

Mohammed:

BP: 60/40mmHg,

Pulse: 55/ min

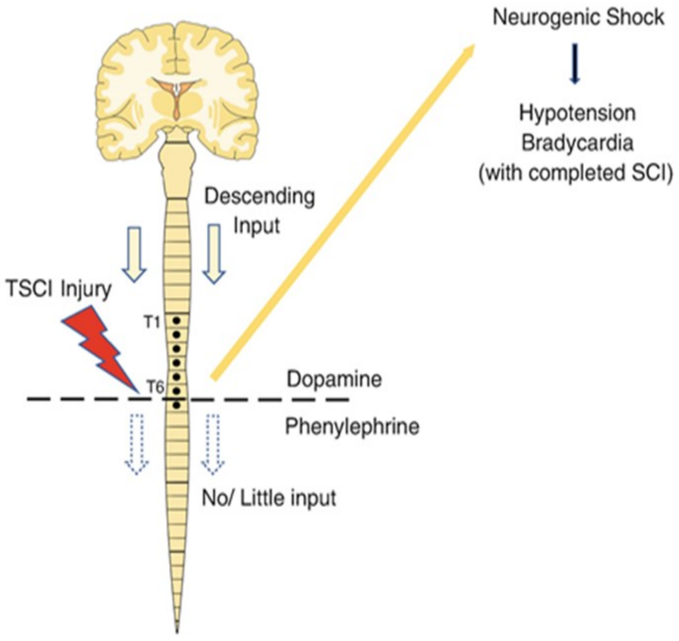
Respiratory rate: 17/min. with normal breathing pattern

2- Interpret the vital signs observed in both victims

During the acute phase of spinal cord injury patients develop **spinal shock with neurogenic shock**

- Spinal cord injury causes disruption of descendent pathways from central control centers to spinal sympathetic neurons, originating into intermediolateral nuclei of T1–L2 spinal cord segments.
- Loss of supra-spinal control over sympathetic nervous system results in reduced overall sympathetic activity below the level of injury and unopposed parasy
vagal r

Bradycardia and severe arterial hypotension



https://images.app.goo.gl/NWRGAzzrreiqqX8

When they reached the hospital, they were started **pain killers, Intravenous fluids**, and **corticosteroids**.

3- a. Which strong pain killer do you suggest to Sami?

b. What is its mechanism of action?

Opioids are often used in acute care :

- After the trauma resulting in **spinal cord injury (**SCI), **strong opioids (**such as **morphine)** are possibly used, and would have been very good at controlling the acute pain of the injury.

- **Over time however**, this situation changes and opioids become less and less effective. **For chronic pain, opioids are NOT very effective at all**, and they often have very **severe and unpleasant side effects**

Mechanism of action:

Opioid drugs produce their action by acting on opioid receptors:

- **Opioid receptors are membrane receptors coupled to G-protein**:

1- □ Adenylate cyclase → □ cAMP.

2- Open K^{+}-Channel → Hyperpolarization.

3- Block Ca^{2+}-Channel

- **Types of opiod receptors and action results of their activation:**

1- **Mu** (μ_1 & μ_2): Analgesia (Spinal & Supra-spinal), Euphoria, Sedation, Dependence, ↓ R.C., Miosis & Constipation.

2- **Kappa (κ_1, κ_2 & κ_3):** Analgesia (Spinal & Supra-spinal), Dysphoria, Psychotomimetic, Less ↓ R.C. & Less Miosis

3- **Delta (δ_1 & δ_2):** Analgesia (Spinal mainly) & Constipation.

It is to be noted that :

- There are a range of medications that can be helpful for spinal cord injury pain after the acute phase :
- It is very important to match the type of medication to the type of

  pain for the best results:

➢ Musculoskeletal pain:

responds well to simple analgesics (paracetamol, NSAIDs)

➢ Neuropathic pain :

Some of the anti-convulsants (or anti-epileptics) are used like gabapentin and pre-gabalin and they work by reducing the excitability and the abnormal firing in

4- Why both Sami and Mohammed were given steroids?

- **Corticosteroid is given to** reduce swelling, which is a common cause of secondary damage at the time of injury.
- **After the initial tissue damage associated with a spinal cord injury**, **inflammatory response is manifested through:**

tissue ischemia, oxidative stress, inflammatory, and immune responses.

Steroids such as Methyl prednisone are utilized in the reduction of oxidative stress as it is a primary degenerative event post trauma. Additionally, higher doses have illustrated neuroprotective and immunosuppressive capacities through the release of interleukins, reducing Ca2+ aggregation and necrosis limiting the progression of ischemia.

Welcome Back

Terrorist attack

ny was **conscious and oriented**

Motor examination of the officer **Samy** revealed:

Left side:

Upper limb: no abnormality detected

Lower limb: no abnormality detected

Right side:

Upper limb:

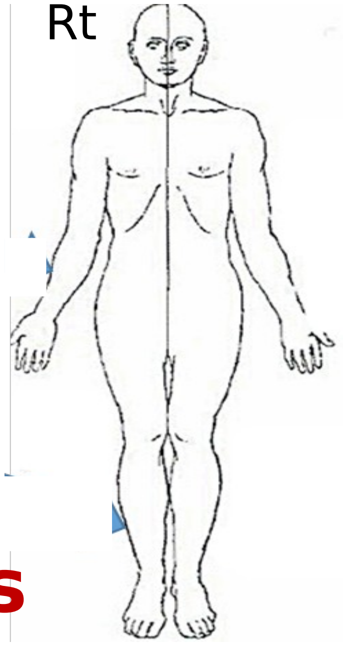
Unable to extend the elbow with weak flexion of elbow and **weak hand grip**.

Decreased muscle tone with **lost triceps reflex** while **biceps and brachio-radialis reflexes were intact**.

Lower limb:

Unable to move his lower limb at all.

Decreased muscle tone with absent deep tendon jerks.



Lost triceps reflex

Loss of movement tone

Terrorist attack

Sensory examination of the officer **Samy** revealed:

Left side:

Partial **loss of the pricks of pin** over his lower limb, trunk, and medial aspect of upper limb and hand (including the middle finger).

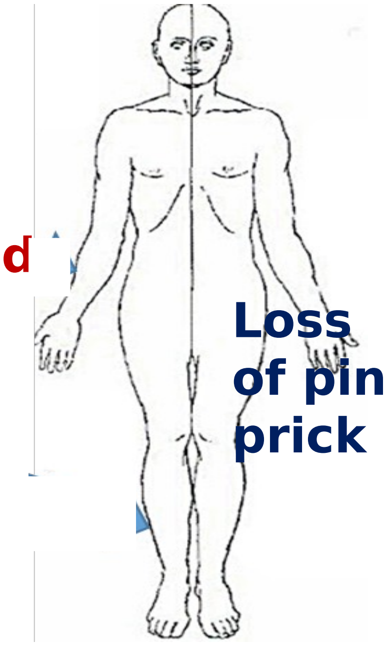
Right side

Loss of vibration sensation.

Loss of position and movement.

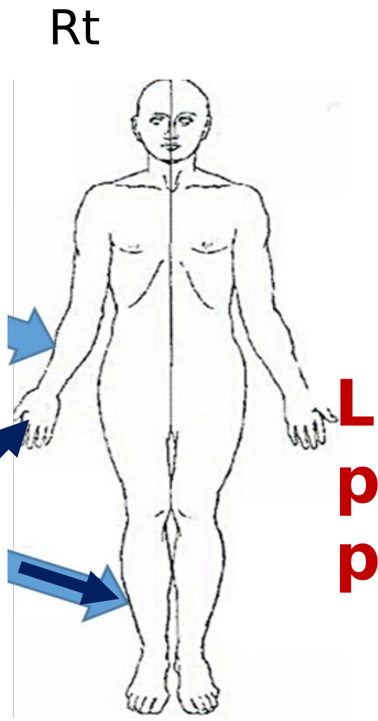
sensations .

nial nerve examination: no abnormality



Terrorist attack

Motor and sensory examination of the officer **Samy** revealed:



Loss of *sense of position and movement*, Loss of vibration

Loss of movement and ↓ tone

Loss of pin prick

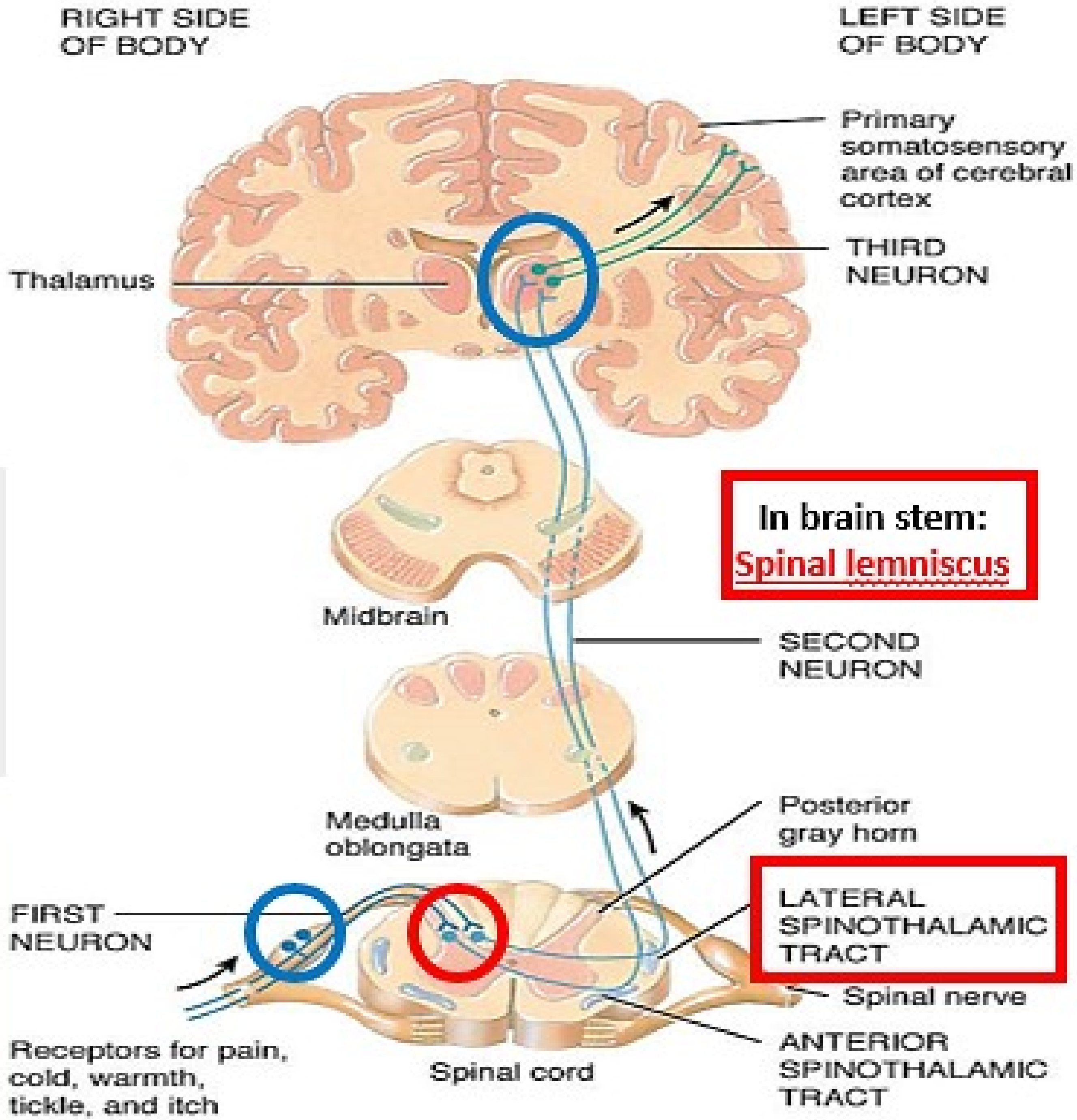
How could you examine the integrity of the sensory tracts in Samy and Mohamed?

Left side of Samy examination:
Partial **loss of the pricks of pin** over his lower limb, trunk, and **medial aspect** of upper limb and hand (including the middle finger) on the left side more than the right side.

Which tract is affected?

Mention the pathway of pain sensation

Pathway for Pain and Temperature


RIGHT SIDE OF BODY
LEFT SIDE OF BODY
Primary somatosensory area of cerebral cortex
Thalamus
THIRD NEURON
Midbrain
SECOND NEURON
Medulla oblongata
Posterior gray horn
FIRST NEURON
LATERAL SPINOTHALAMIC TRACT
Spinal nerve
Receptors for pain, cold, warmth, tickle, and itch
Spinal cord
ANTERIOR SPINOTHALAMIC TRACT

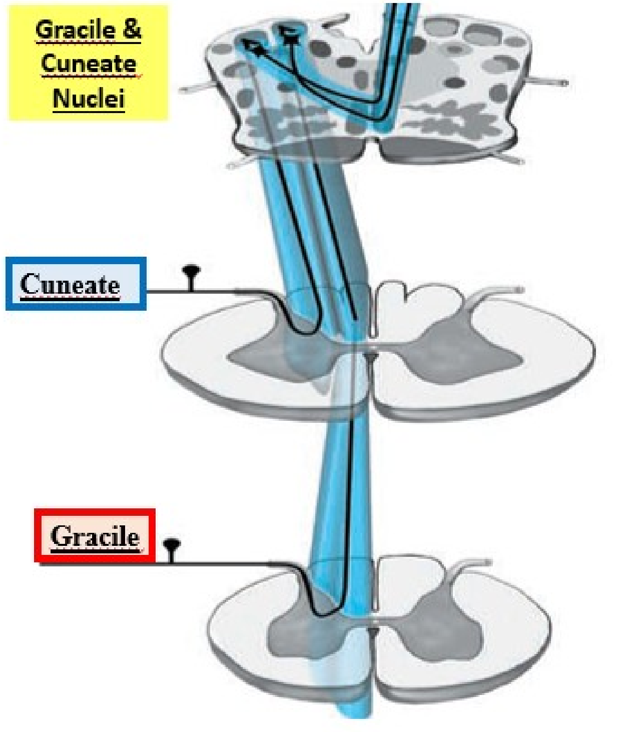
In brain stem: Spinal lemniscus

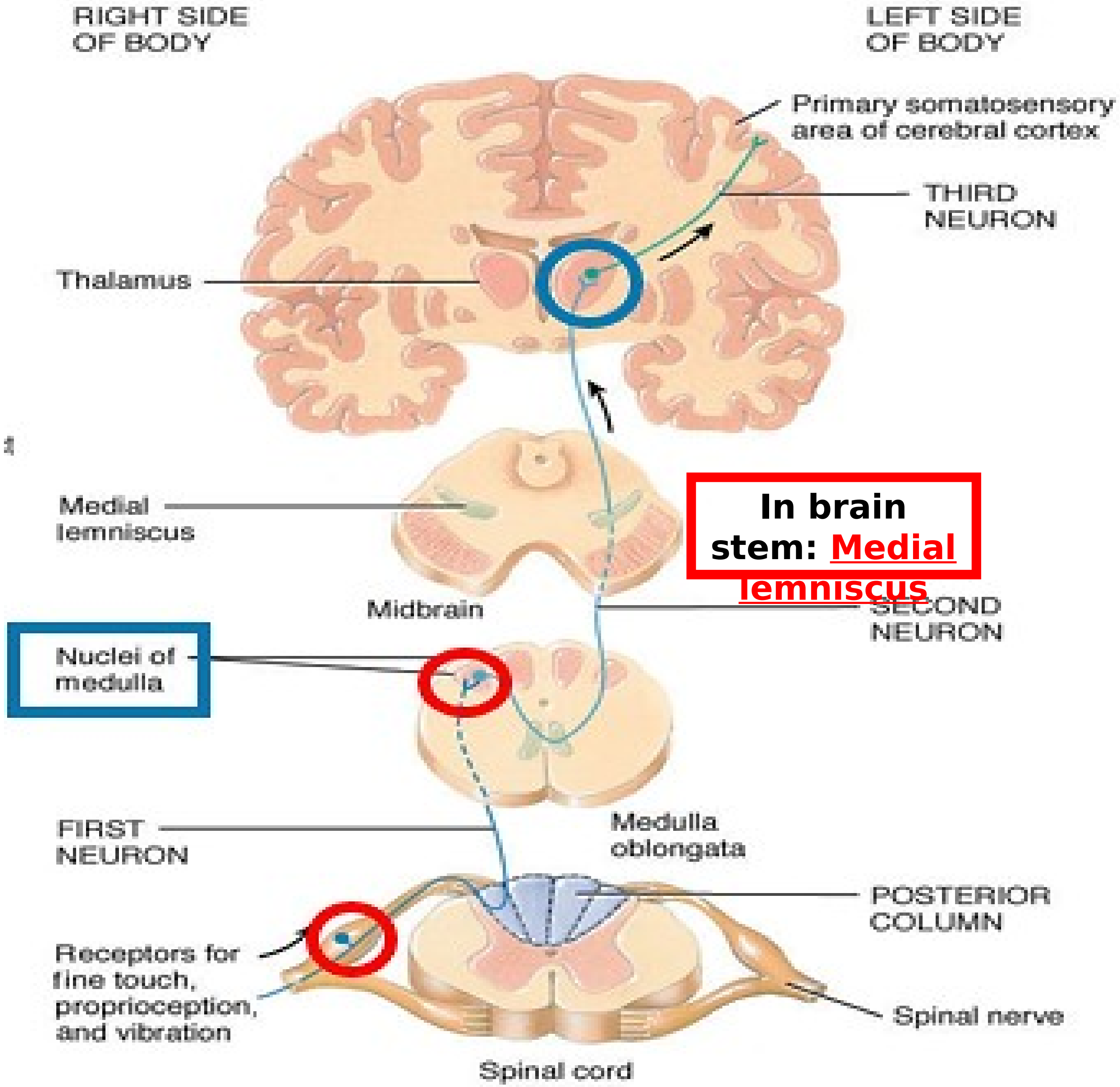
Right side of Samy examination:

Loss of joint and vibration sensation on the right side more than the left side.

4- Which tract is affected?
Mention the pathway of movement and vibration sensation

Pathway for Proprioception and Fine Touch





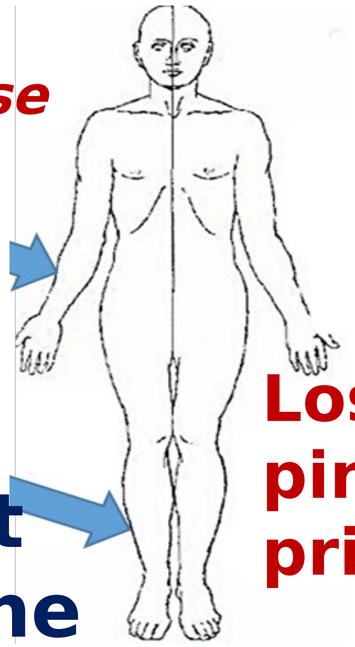
In brain stem: **Medial lemniscus**

6- a-Which sensory tracts are affected?

b- On which side?

c- Justify your answer

Rt

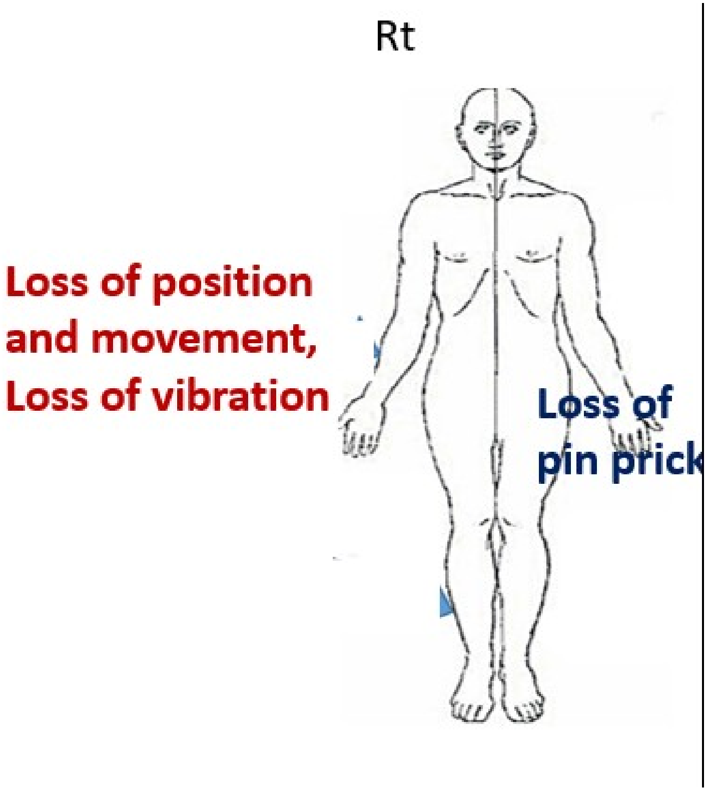


Loss of *sense of position and movement,*
Loss of vibration

Loss of movement and ↓ tone

Loss of pin prick

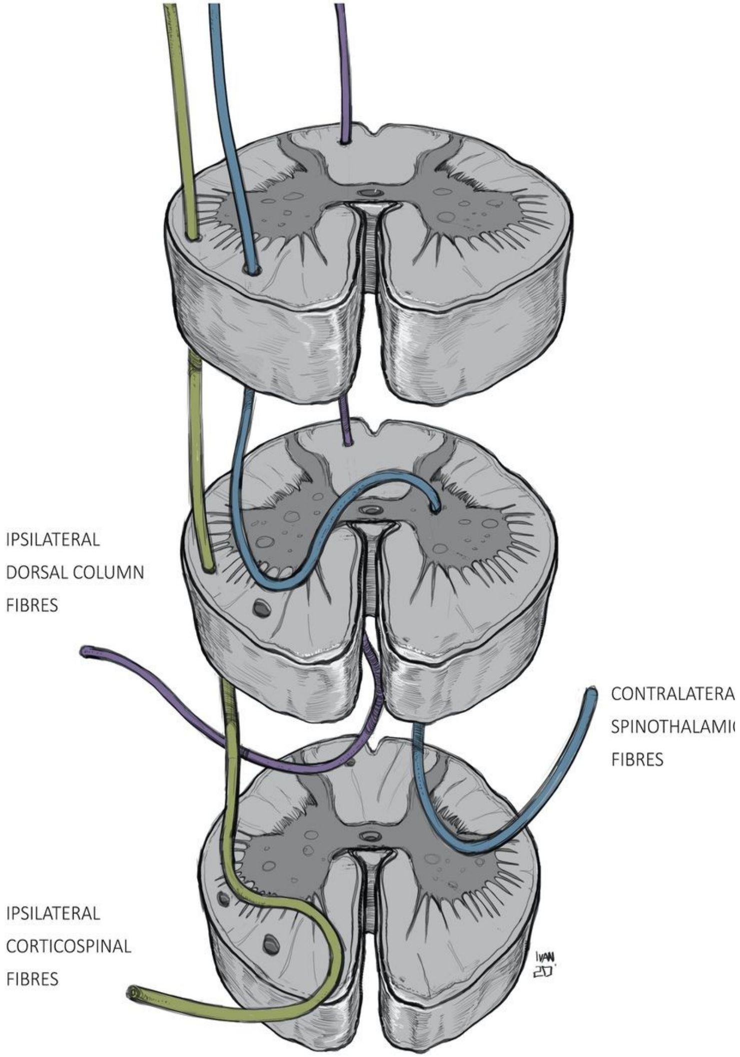
7- Interpret the dissociation of sensory loss in Samy

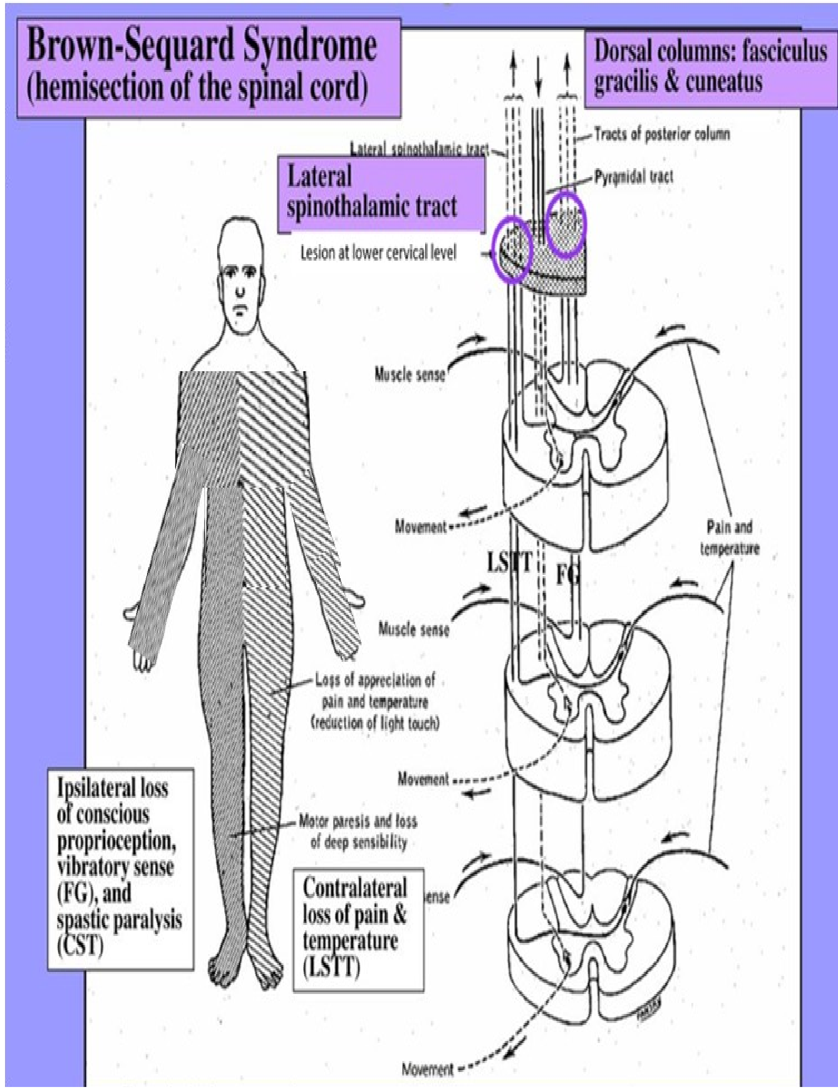


Dissociation of sensory loss in Samy

- Dorsal column tract and the corticospinal tract both cross at lower part of medulla

- Spinothalamic tract cross at the spinal cord level

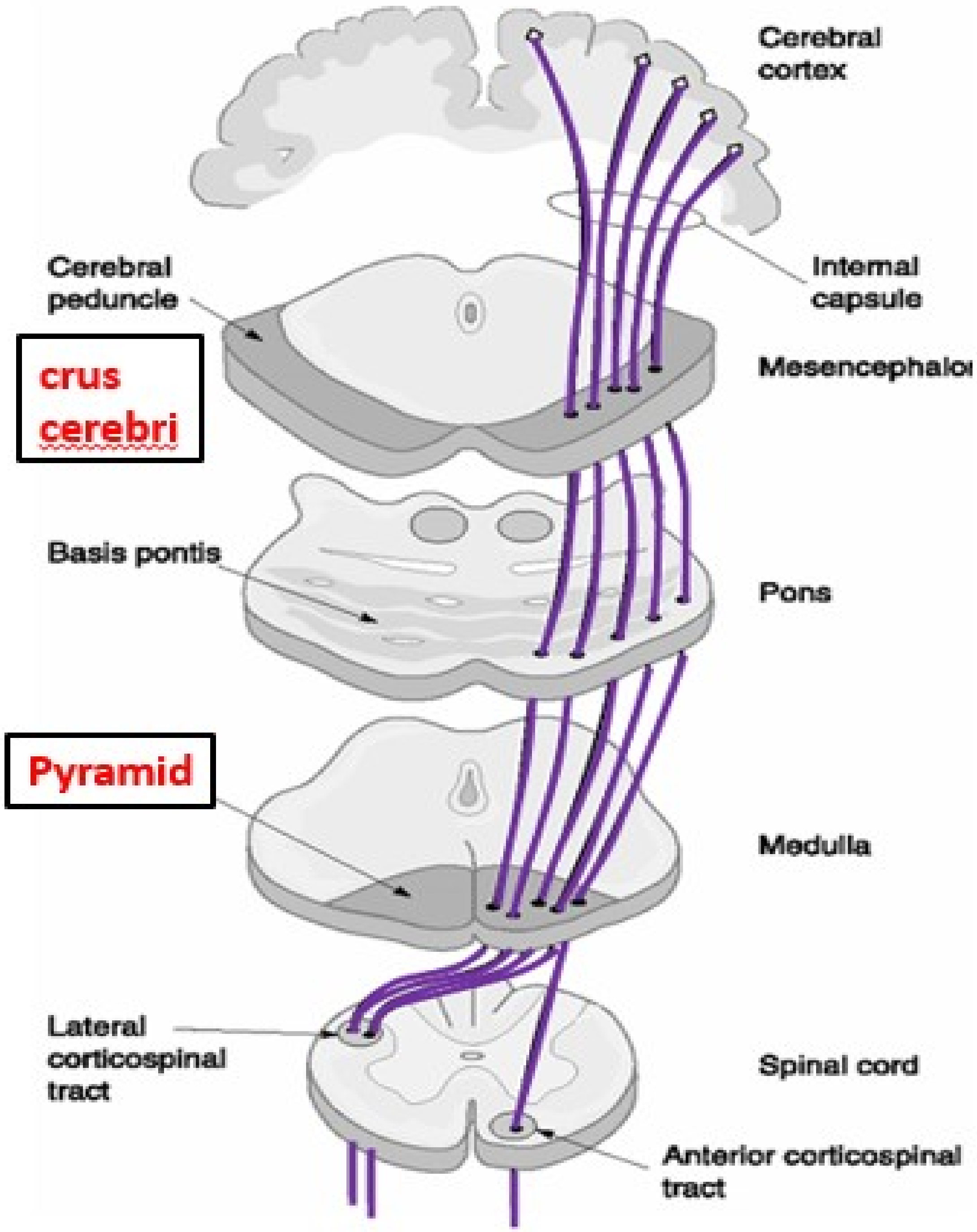


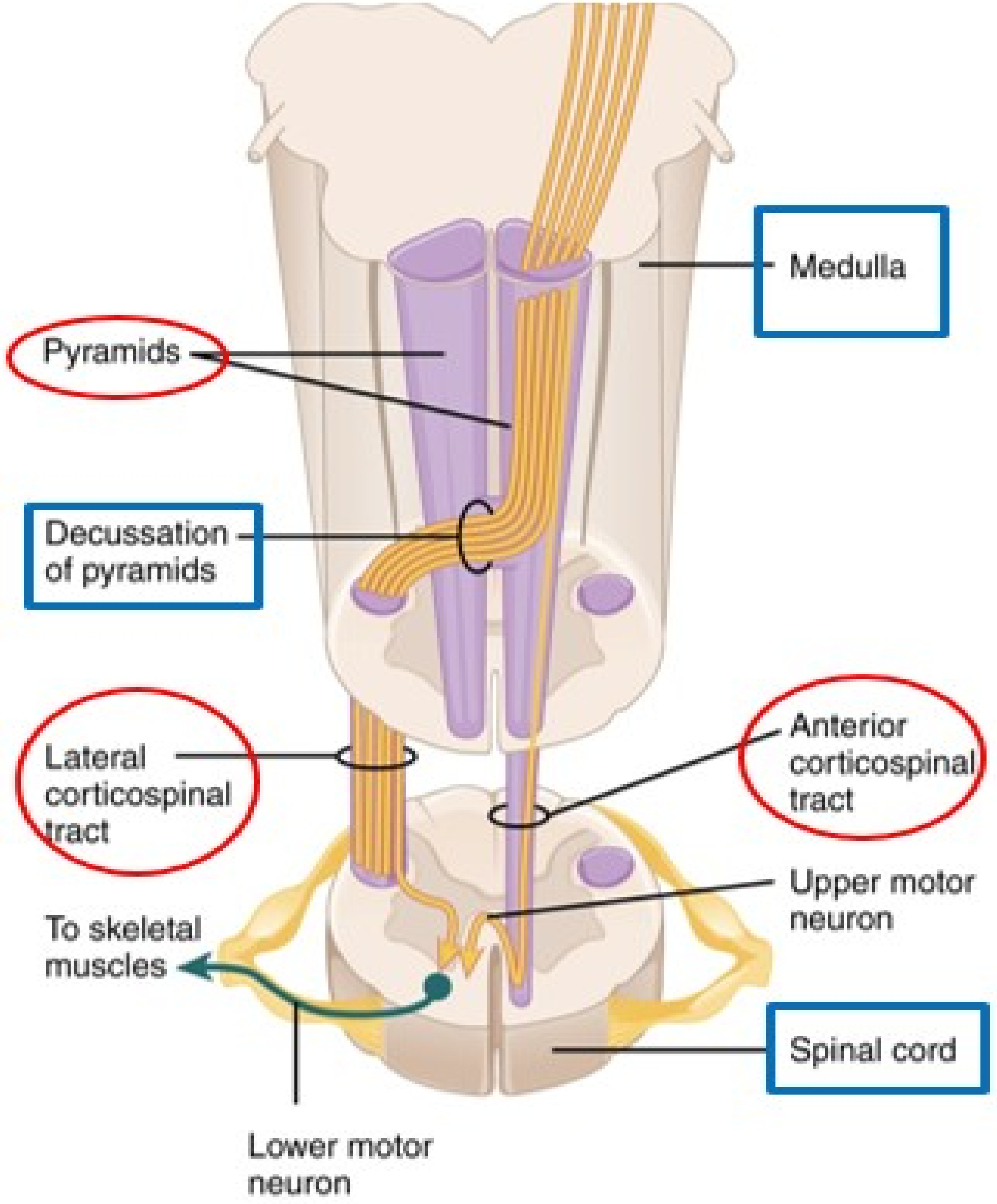

Brown-Sequard Syndrome
(hemisection of the spinal cord)
Dorsal columns: fasciculus gracilis & cuneatus
Tracts of posterior column
Lateral spinothalamic tract
Pyramidal tract
Lateral spinothalamic tract
Lesion at lower cervical level
Muscle sense
Movement
LSTT
FG
Pain and temperature
Muscle sense
Loss of appreciation of pain and temperature (reduction of light touch)
Movement
Motor paresis and loss of deep sensibility
Ipsilateral loss of conscious proprioception, vibratory sense (FG), and spastic paralysis (CST)
Contralateral loss of pain & temperature (LSTT)
sense
Movement

Samy had loss of movement on the right upper and lower limbs

8- a- Which tract is affected?

b- Mention its pathway


Cerebral cortex
Cerebral peduncle
crus cerebri
Internal capsule
Mesencephalo
Basis pontis
Pons
Pyramid
Medulla
Lateral corticospinal tract
Spinal cord
Anterior corticospinal tract


Medulla
Pyramids
Decussation of pyramids
Lateral corticospinal tract
Anterior corticospinal tract
Upper motor neuron
To skeletal muscles
Spinal cord
Lower motor neuron

Right side examination of Samy:

Unable to move his lower limb nor flex the elbow nor moving his shoulder with weak hand grip.

Decreased muscle tone with lost triceps reflex while biceps and brachioradialis **reflexes** were intact.

What is the interpretation of reduced tone?

Right Upper limb examination of Samy:

Unable to **neither flex or extend the elbow** nor moving his shoulder **with *very* weak hand grip**.

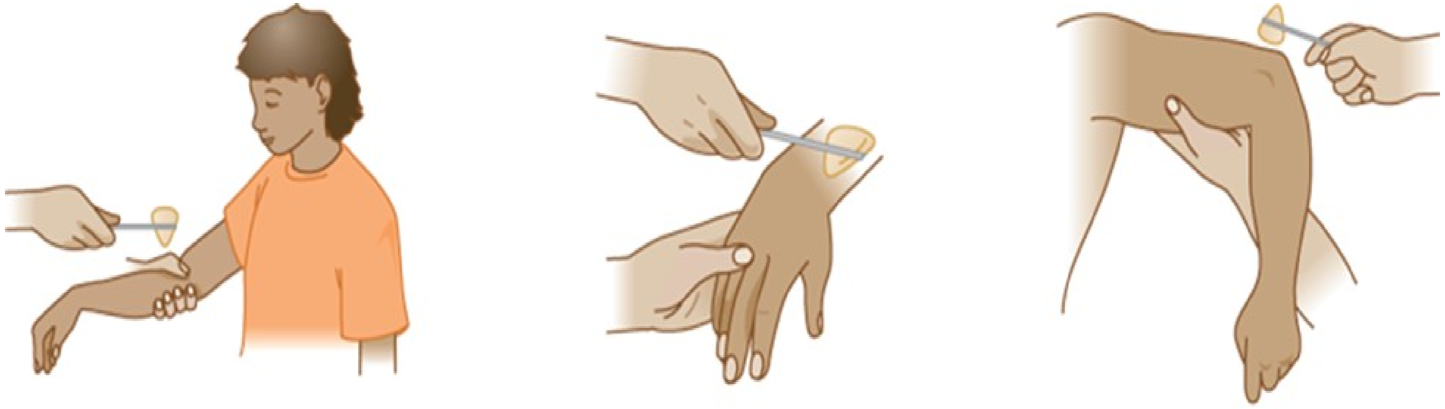
Decreased muscle tone with **lost triceps reflex** while **biceps and brachioradialis reflexes were intact**.

uld you deduce what is the level of the lesion?

stify your answer

evel of the lesion?

The lesion level is mostly Level at c7



Biceps reflex
C5,6

Brachioradialis reflex
C5,6

Triceps reflex
C7,8

Source: Roger P. Simon, Michael J. Aminoff, David A. Greenberg: Clinical Neurology, Tenth Edition
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Welcome Back

Terrorist attack

urological examination of Mohammed revealed:

Mental state: conscious, oriented, of depressed mood.

Motor examination

- No movement in all four limbs But Slight movement of the shoulder.
- Absence of the **deep reflexes**.
- Decreased tone

Sensory examination

Loss of superficial of all **dermatomes** and deep sensation of the 4 limbs up to shoulders

nial nerve examination: no abnormality detected

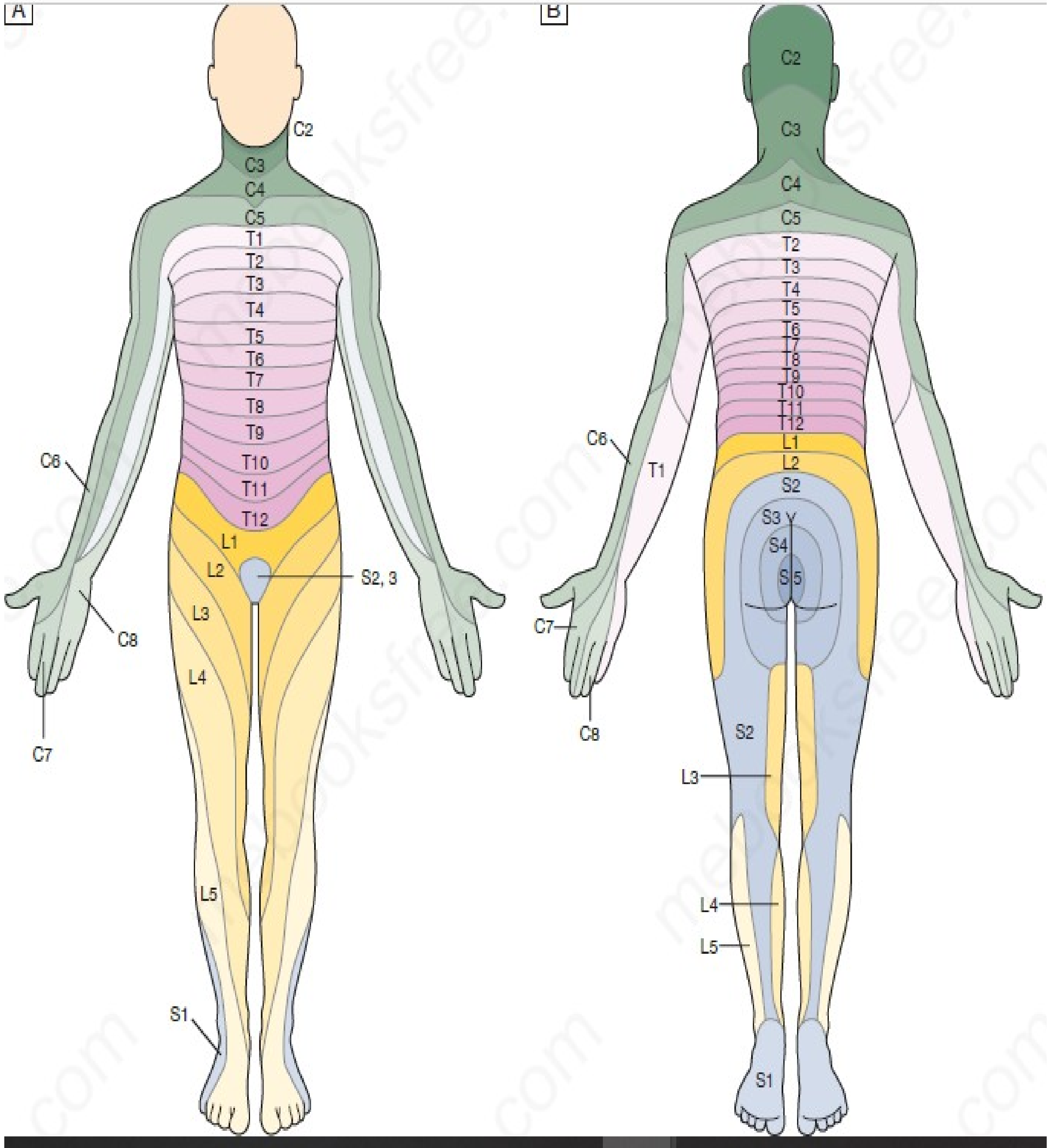
Mohammed couldn’t move both upper and lower limbs But Slight movement of the shoulder.

What are the probable causes?

Mohammed revealed:

No movement in all 4 limbs with **Slight movement of the shoulder**.
Absence of the **deep reflexes** and deep sensations of the 4 limbs.
Loss of superficial sensations of all **dermatomes up to the collar**

Could you deduce what is the level of the lesio
Justify your answer



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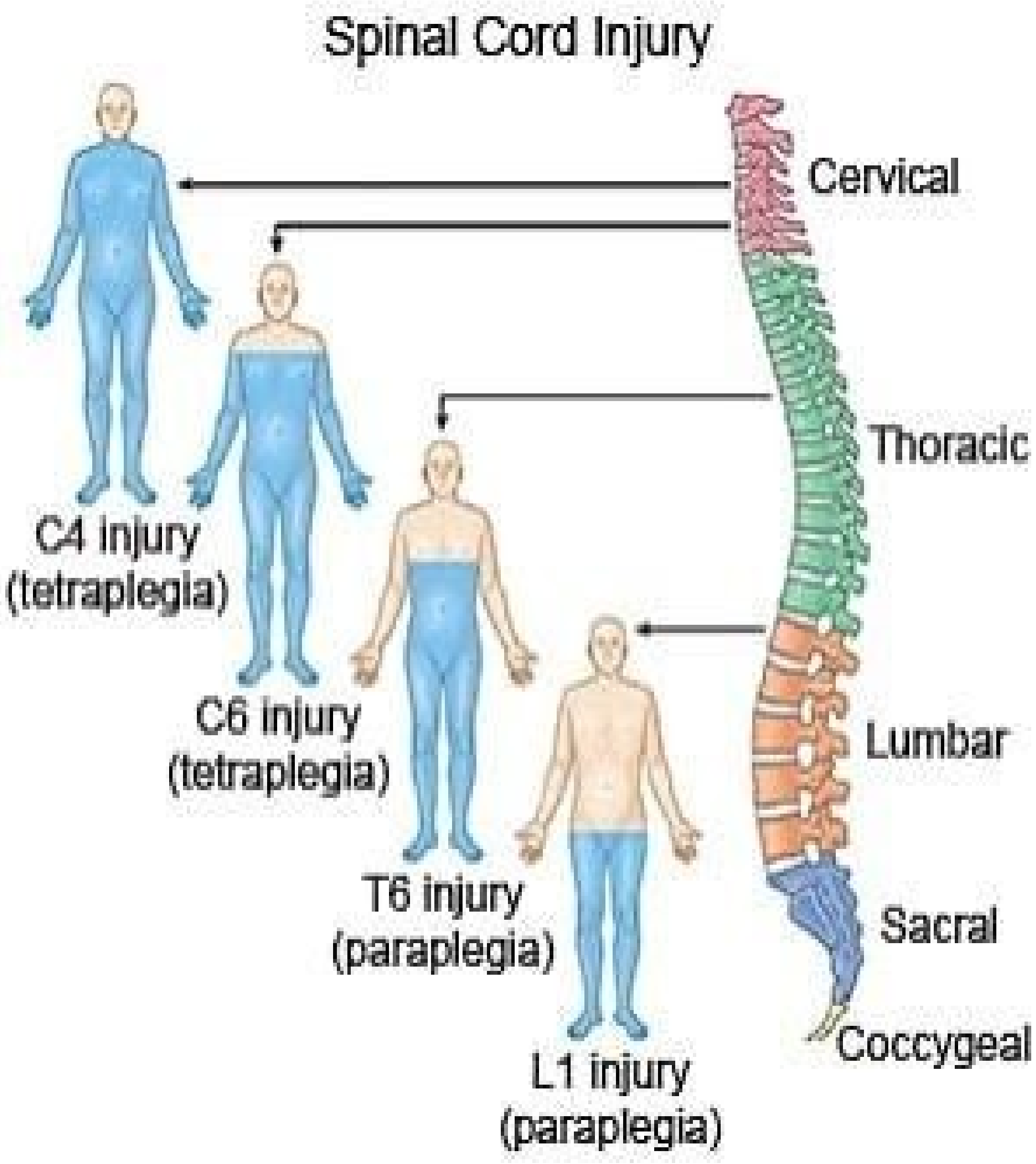
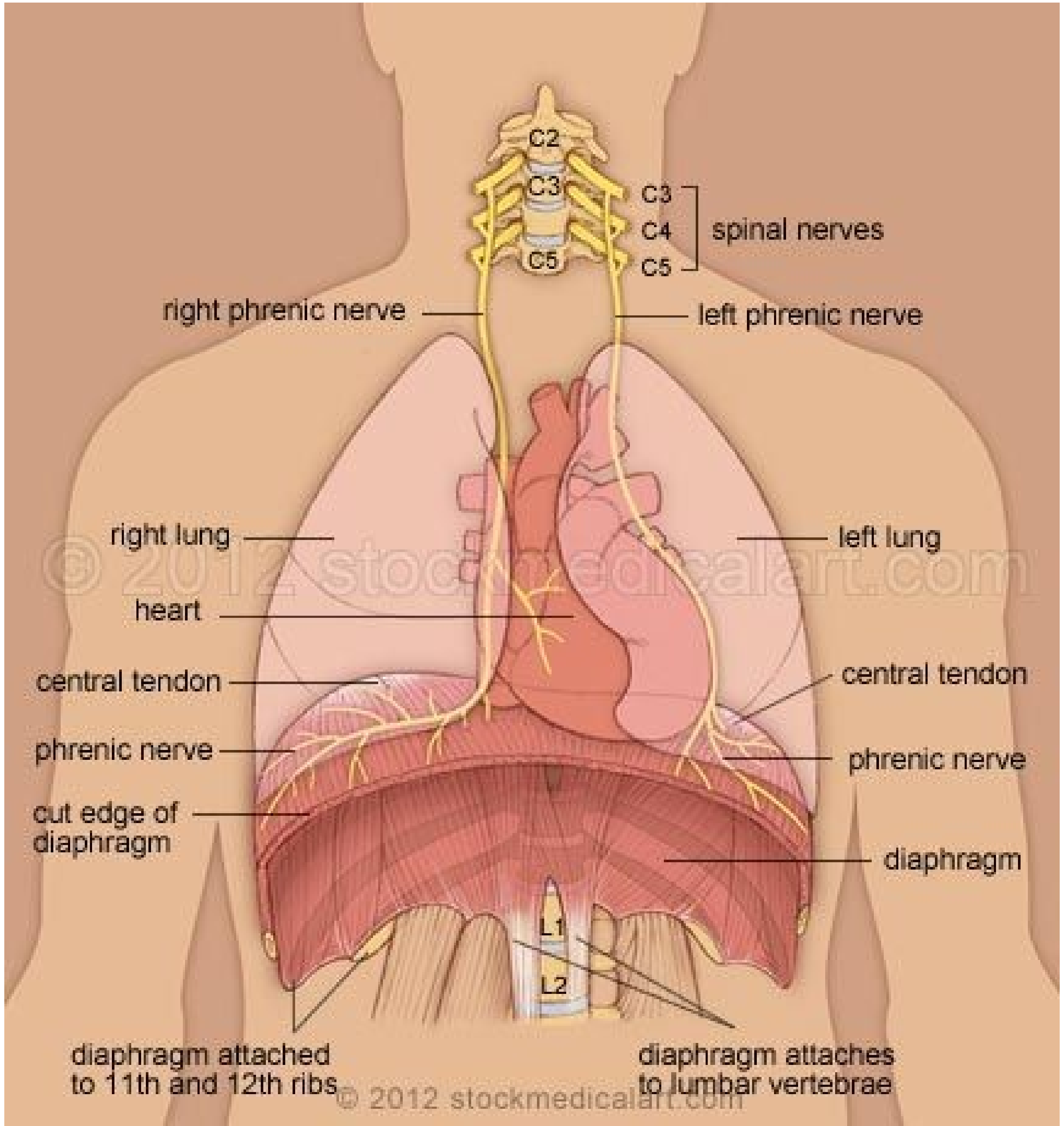


9- Could respiration be affected in Mohamed?



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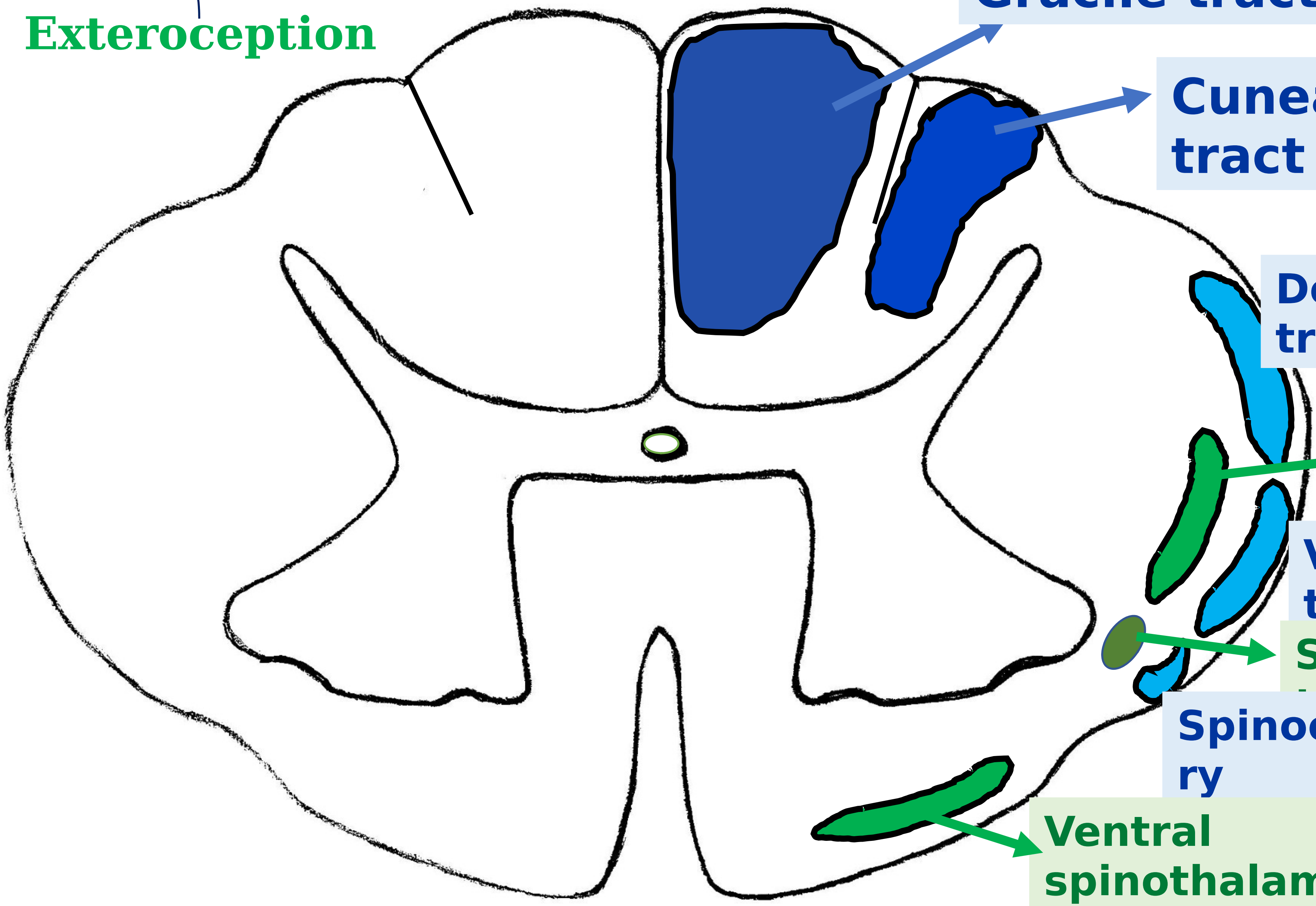
10- Name the tracts present in the white columns present at the level of the lesion and their position

Ascending Tracts

Proprioception

Exteroception



Gracile tract

Cuneate tract

Dorsal SC tract

Lateral spinothalamic

Ventral SC tract

Spinotec

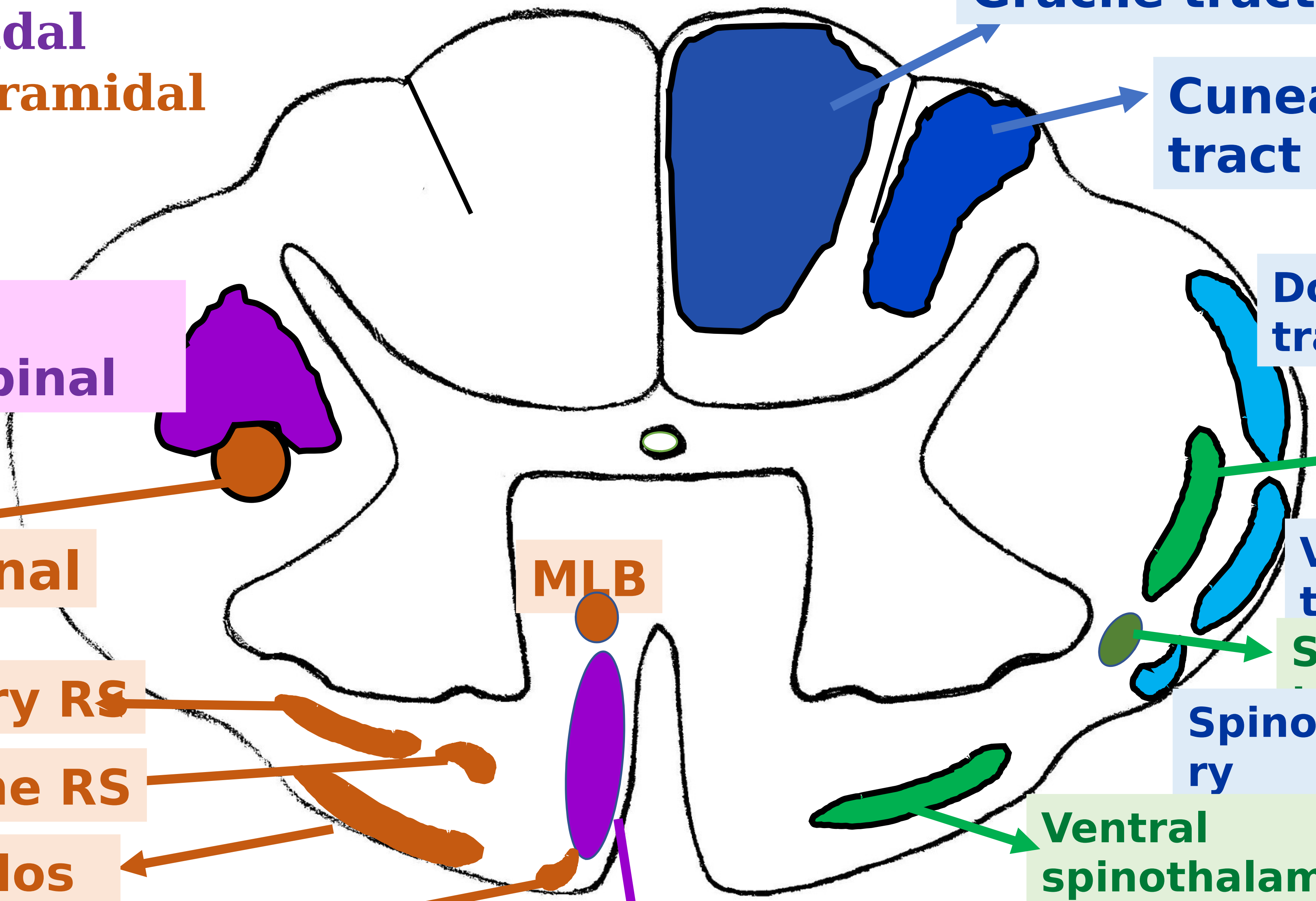
Spinoolivary

Ventral spinothalamic

Descending Tracts

Pyramidal tract

Extrapyramidal tracts



Gracile tract

Cuneate tract

Dorsal SC tract

Lateral spinothalamic

Ventral SC tract

Spinotec

Spinooliva ry

Ventral spinothalamic

Lateral corticospinal

ubrospinal

MLB

Medullary RS

Pontine RS

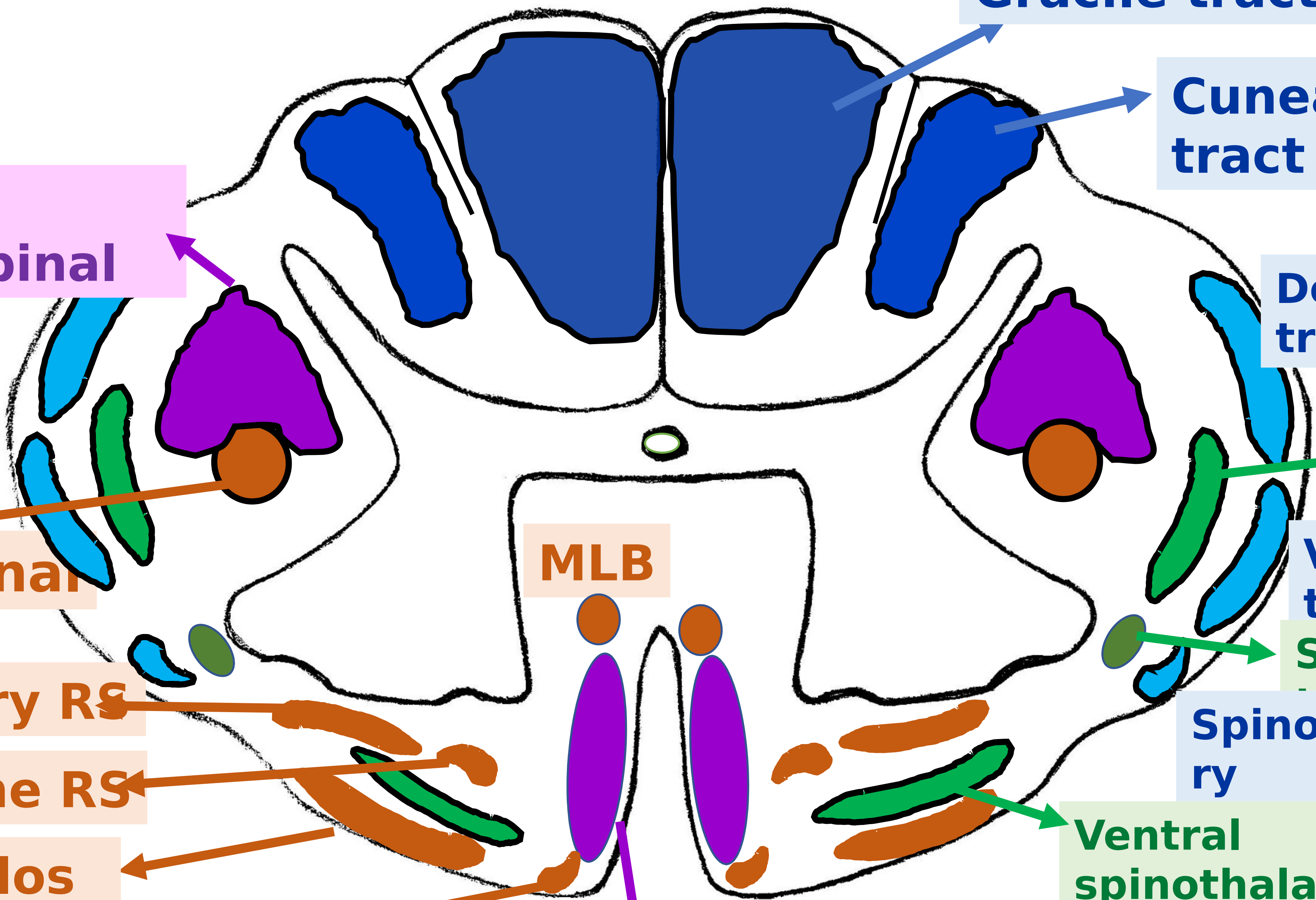
Vestbulos pina

Tectospina

Anterior corticospinal

Dr Manal Hasssan, Dr Mostafa

All Tracts



Gracile tract

Cuneate tract

Lateral corticospinal

Dorsal SC tract

Lateral spinothalamic

ubrospinal

MLB

Ventral SC tract

Spinotec

Medullary RS

Spinooliva ry

Pontine RS

Ventral spinothalamic

Vestbulos pina -

Tectospina

Anterior corticospinal

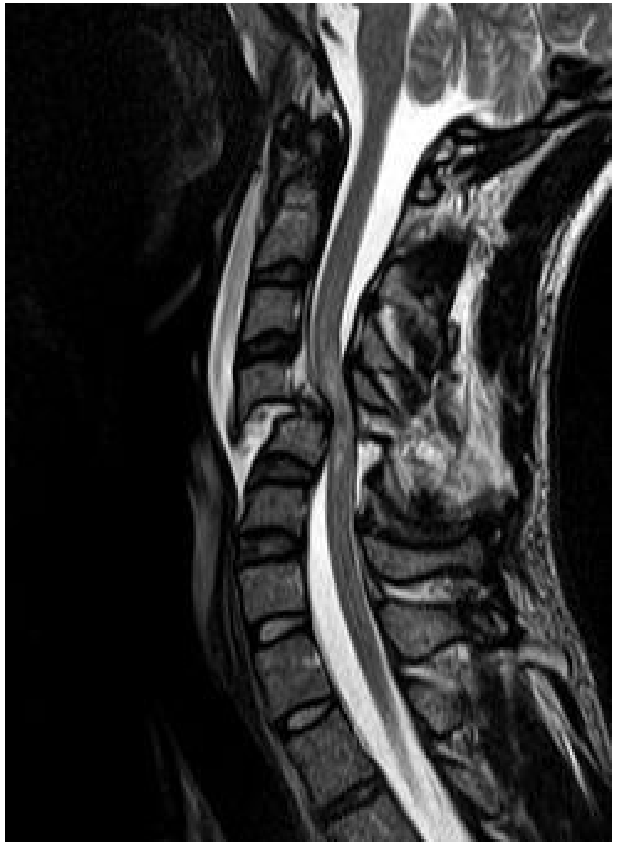
Welcome Back

Terrorist attack

Management

X ray and MRI Cervical spine at the level of injury was done to assess **injury**.

Samy had removal of a fragment.



Mohammed had **Decompression and fixation** using plate and screws for C4,5.

Terrorist attack

2 weeks after hospitalization, Samy started to develop ***spasticity in the right upper and lower limbs***, **Babinski sign** was positive and the power of the hand was partially resumed.

Mohammed showed urine incontinence. Mohamed also showed mild improvement in the four limbs but **more in the lower limbs**.

The two friends were discharged from the hospital and referred to the **physical medicine department for rehabilitation.**

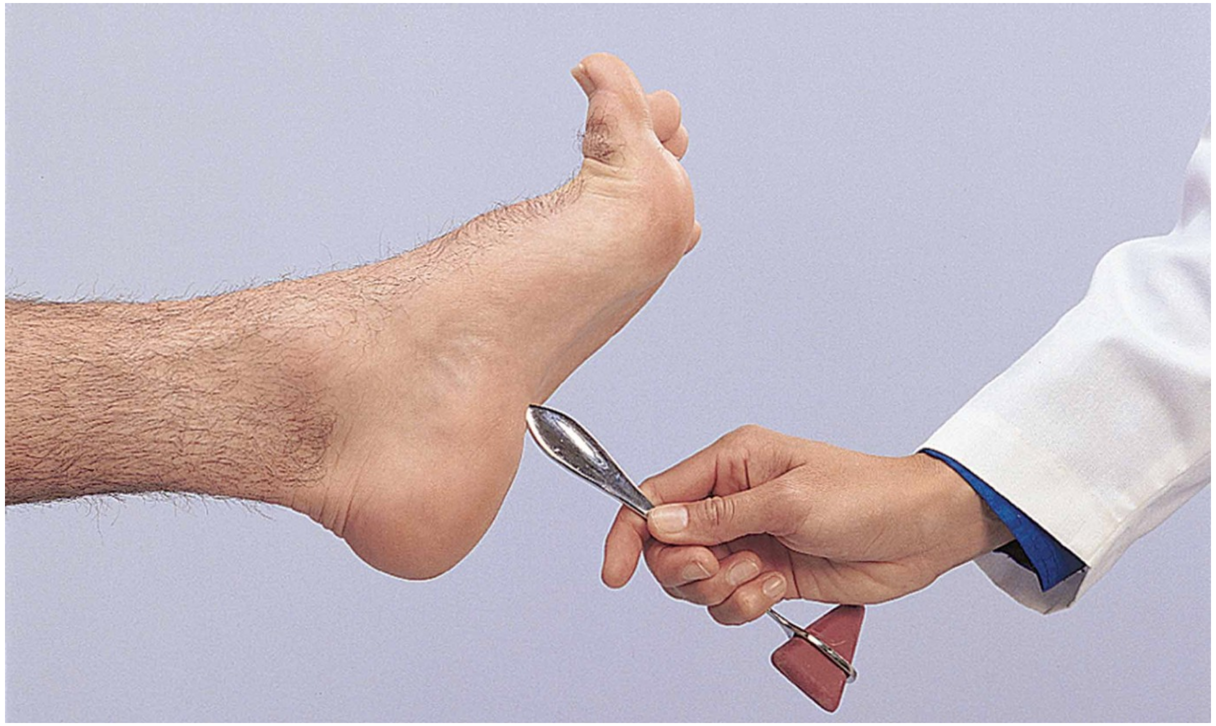
After 6 months of intensive physical therapy, both

2 week after hospitalization, Samy started to move his right lower limb; the tone in the limb began to increase, **Babinski sign** was positive and the power of the hand was partially resumed.

11- What is relevance of Babiniski sign?

Babiniski sign?

- The positive Babinski sign **indicates chronic UMNL (pyramidal) affection**, damage to the corticospinal tract
- Dorsiflexion of the big toe
- Fanning of other toes



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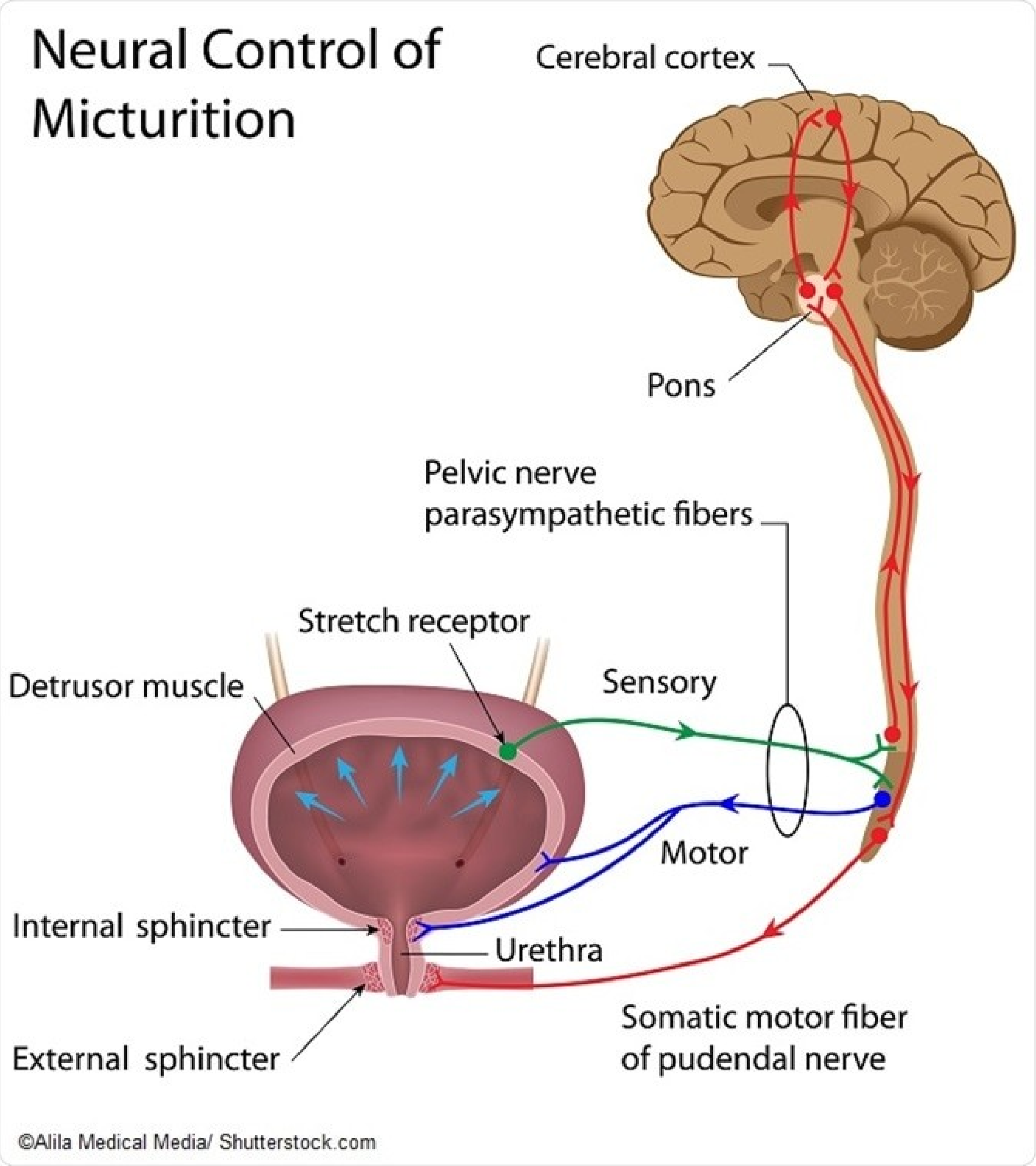
Mohamed had **urine incontinence**

Explain

Micturition reflex

- Micturition reflex in adults is controlled by supra-spinal centers.
- **The brain cause either facilitation or inhibition according to the situations.**
-



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Micturition abnormalities

- **Atonic bladder**

Loss of bladder sensation

Cause:

- **Shock stage of complete spinal cord transection**
- Interruption of sacral dorsal nerve roots as in tabes dorsalis
- Destruction of sensory nerve fiber from urinary bladder to spinal cord

Loss of micturition reflex

Retention with overflow

- **Automatic bladder**

Loss of voluntary contraction

- **Cause:**

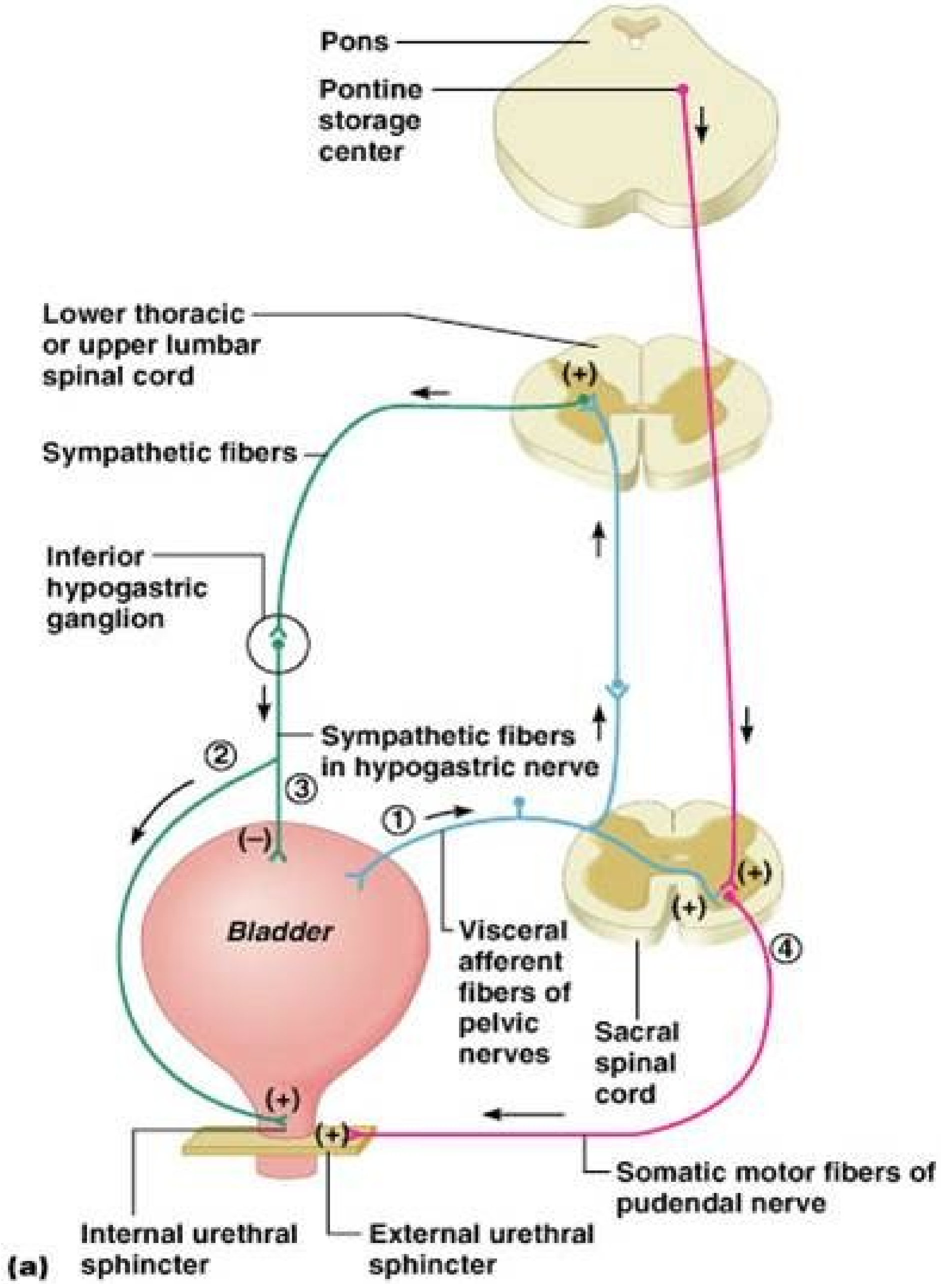
Disconnection of sacral micturition center from brain due to spinal cord transection above sacral region: stage of recovery of reflexes

Reflex bladder evacuation

Mohamed is **in a spinal shock stage**

- Loss of all spinal reflexes: including spinal visceral micturition reflex

Leading to distension of bladder and dribbling of urine , a condition called retention with overflow


Pons
Pontine storage center
Lower thoracic or upper lumbar spinal cord
(+)
Sympathetic fibers
Inferior hypogastric ganglion
Sympathetic fibers in hypogastric nerve
②
③
①
(−)
Bladder
Visceral afferent fibers of pelvic nerves
(+)
(+)
Sacral spinal cord
④
(+)
(+)
Somatic motor fibers of pudendal nerve
Internal urethral sphincter
External urethral sphincter
(a)

https://images.app.goo.gl/PJCk7xKuEf4yhzX9

They were discharged from the hospital and referred to the **physical medicine department for rehabilitation**

Explain

to minimize muscle wasting that would occur due to lack of movement (disuse atrophy)

12- Is regeneration possible?

Explain

Regeneration of CNS

Certain regions of the CNS, retain rare **neural stem and progenitor cells** that allow some replacement of neurons throughout life.

Neural plasticity involving formation and remodeling of synaptic connections is also prevalent throughout life.

However,

The complexity and distances of the neuronal and glial interconnections with the CNS make regeneration and restoration of function within this tissue after major injury very difficult.

Explain the partial recovery notices

- After few days, the shock stage disappears, patient regain tone (spasticity).
- The bladder regain the tone>>> spastic bladder.
- **The majority of recovery occurs within the first six months after injury. Any remaining loss of function present after 12 months is much more likely to become permanent.**

Take Home Messages

- Cord injury is characterized by presence of **motor, sensory, autonomic levels and sphincteric** affection.

- **Early intervention** in acute cord lesions and proper management can save motor functions.

Thank you